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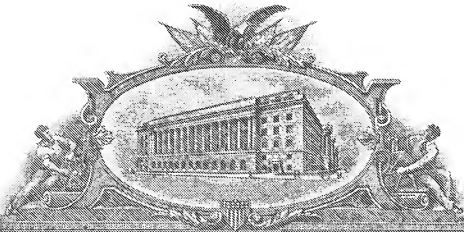
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Additional inventors are being named on the _____ separately numbered sheets attached hereto					
<b>TITLE OF THE INVENTION (500 characters max)</b>					
The Hard Drive Haven					
Direct all correspondence to: <b>CORRESPONDENCE ADDRESS</b>					
<input type="checkbox"/> Customer Number: <span style="border: 1px solid black; display: inline-block; width: 150px; height: 1.2em; vertical-align: middle;"></span>					
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Respectfully submitted

[Page 1 of 2]

Date, February 14, 2004

SIGNATURE

REGISTRATION NO. \_\_\_\_\_

(if appropriate)

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## **PROVISIONAL PATENT APPLICATION**

### **SPECIFICATION**

**TO ALL WHOM IT MAY CONCERN:**

BE IT ALL KNOWN THAT I, Paul Douglas Cochrane, holder of an H-1B Visa, and a citizen of Canada has invented a packaging solution for hard disk drives that is a comprehensive embodiment of what is required to promote long term, reliable hard disk drive performance. In addition to the complete address of the hard disk drive packaging requirements, the invention is a highly cost conscious approach and in such offers a very high level of value. The solution can be implemented for any number of hard drives, individually or in any multi-disk configuration. The inventor has applied a name to the invention, which is intended to portray the essence of the value which it embodies. The device, should there be no unknown barriers to its use, shall be called the Hard Drive Haven, of which the following is a specification:

## Hard Drive Haven

### Background of the Invention:

#### Field of the Invention

The present invention relates generally to hard drives and more specifically it relates to an all encompassing solution for the storage of hard drives in a single or multi-hard drive environment. Although the invention is initially being developed for hard disk drives, there would be no impediment to extending the concept into many appropriate applications, without any fundamental change in the implementation.

#### Description of the Related Art

The hard disk drives (HDD) are mounted in a wide range devices and physical locations. From personal computers to Storage Area Networks (SAN) to Network Attached Storage (NAS) appliances, such as Redundant Array of Inexpensive Disks (RAID) arrays, Just a Box of Disks (JBODs), servers and a host of bulk data memory devices. HDD bay or chassis located within a system enclosure in a personal computer, in a JBOD, or any other location where the Haven could be easily installed.

During operation, the HDDs generate create vibration as they rotate. By definition, a hard drive system will undergo *rotational vibration* when an oscillating moment is applied. When a hard disk drive is idle, the oscillation can be caused by friction in the spindle bearings or by rotational imbalance of the platter(s). When the drive is under read/write or seek conditions, inertia forces from activity of the actuator arm can cause Rotational Vibration (RV) is characterized by **rad/s**, which is the rotational analog of linear acceleration **m/s<sup>2</sup>** or **g**. When HDDs are packaged in close proximity they can, and most often will, propagate RV from one drive to another degrading drive performance. The vibration can become excessive, particularly when adjacent HDDs are operated simultaneously. Moreover, as HDD technology progresses to faster rotational speeds and cost-reduction architectures, the vibration problems are exacerbated.

In addition to the drive to drive induced vibration, there is also the real possibility of vibration being induced by the environment in which the

drives are located. As an example of this would be in a data closet, where network storage equipment is maintained, there could be a number of external sources that can induce vibration. An air conditioner in any relatively near location would be a specific example.

Vibration can also come in the form of acoustic vibration or the HDDs can produce disturbing acoustic noise, particularly for the consumer product applications. As personal computer become more prevalent in the home and HDDs are being used for audio/video and entertainment applications, acoustic noise emissions are becoming important to consumers. The Hard Drive Haven can provide a extremely cost and function wise effect solution to this acoustic problem.

One major disk drive manufacturer recently stated , that after extensive research it was found that the leading question by consumers with respect to hard drives was *"How loud will this drive be in my system?"* The acoustic noise comes from two noise comes from two sources,

Excessive vibration may lead to decreased HDD performance such as recoverable and non-recoverable write inhibits, increased seek times, and increased read and write access times. Excessive vibration or shock may also cause premature HDD failures that are not repairable. Examples include mechanically-damaged platters and read/write heads, mechanical wear on moving HDD components, and data error defects that cannot be corrected through the use of software tools. Also many HDDs in a confined space results in a substantial amount of heat generation. This heat must be dissipated in order to avoid over heating the HDDs and causing shortened product life. The hard drive haven would be made of polymer which will serve as a dampening device to minimize vibration. It is also a space economical solution, therefore leaving as much open air as possible to maximize air flow volume for cooling the HDDs.

Analysis and resolution of vibration and resultant noise in hard disk drives requires advanced techniques in modeling, analysis and testing, as well as expertise in materials technologies. Knowledge of damping materials and polymer science is one key factor that will help make the Hard Drive Haven an excellent HDD environment. The Hard Drive Haven will possess this knowledge in order to provide the optimum HDD packaging for long term reliable operation.

The nature of almost all problems is the need to resolve opposing constraints. The constraints invariably pull any of the possible solutions to a problem in different directions. Almost without fail, all

solutions find that in improving one problem constraint that they diminish the solution from the aspect of one, or more, of the other imposed constraints. The position of making trade-offs and finding a "balance" of the capabilities needed to satisfy the need(s). The hard drive haven is a rare example of how all constraints can be addressed and improved simultaneously. The Haven offers a complete benign environment for a hard drive. The majority of solutions look to improve the drives performance, the Haven instead offers to provide an environment that the drive will not need to improve, as the threats will be so greatly diminished.

Currently, there is a void in the market as far as a complete solution that addresses vibration, thermal, and all other physical issues (mass, structure...) for hard drives. The Haven does and it does so in a very cost effective manner. As a result of the lack of complete solutions for hard drive packaging, hard drives are not operating at the level of performance that they might otherwise be. The proliferation of hard drives is growing rapidly. The typical CAGR (compound annual growth rate) for the various segments of the Storage Area Network (SAN) and Network Attached Storage (NAS) arenas are growing at a ~67% (typical). An increase in HDD performance will have a significant effect when considering the tremendous numbers of drives in operation. This truth will only grow for the foreseeable future. To operate at it's maximum, while addressing The Hard Drive Haven, while not being completely free of the rule, does come magically close, when looked at from many if its excellent value based vantage points.

The following list articulates a number of attributes that make up the Haven. All of the attributes listed apply to the performance, handling, distribution and long term reliability of hard drives. However, the list would be a very appealing list to many other applications for which the Haven could be easily adapted.

- Low Cost of Manufacturing and low product cost (initial tooling cost has been calculated to be a one day payback for a \$50,000 tool based on extreme market demand and the piece part cost would be exceptionally low as compared to most existing alternatives – injection molding process is most likely , but not the only possibility).
- Minimal part count, light weight and application flexible

- Thermal Environment - minimal structure allowing maximum cross section for cooling air flow
- Vibration & Shock Isolation and Damping
- Minimal Packaging Complexity – with maximum hard drive density
- Acoustic Noise Reduction
- High Mechanical Integrity
- Structural Stability and Efficiency
- Minimal Mass (Mass Efficiency) –important in that HDDs are massive and the loads on data-com equipment racks will go up sharply with densely packaged hard drives, particularly if the packaging weight is not minimized.
- Reliable Interconnect (Hot Plug) - Intelligent use of forces to create simple, highly reliable connector alignment, with no mechanical piece parts
- Electro-Static Discharge
- Ground isolation, advance pins on hot plug handle the discharge of any discharge
- Simple Field Replacement Ability- could even ship hard drives in OEM packaging for direct installation in the SAN and NAS.
- Simple Field Serviceability – Drive Level Replacement (with no additional replacement components)
- Design for Minimal Field Service
- Industrial Design is facilitated by existing faceplate design and snap fit features for assembly into the HDH.



The hard drive Haven has an integral vibration shock and acoustic noise dampening and isolation. The vibration dampening system has springs of polymeric material located between the inner surfaces of the haven and the hard disk drive. The inventive suspension system holds the hard drive in a slot in the structure with the polymer springs. The polymer springs isolate the hard drive from the side panels and dampen the vibration produced by the hard drive itself as well as the vibrations transmitted through the sidewalls of the hard drive bay housing. The side walls also act as low mass, highly efficient structural members within the system. The minimal structure allows for significant air flow to provide the cooling that is critical to HDD reliability. The polymers have been and continue to be engineered to be ideally suited to this application or similar applications. The beams are designed to consider temperature effects, creep and long term fatigue of the plastics. Multiple beams will be recruited to support the drives and each other to ensure that no individual beam sustains all of the load, or even a substantial portion of the load, and that no individual beam could cause a fatigue failure. The Haven will utilize a highly distributed load sharing approach and is designed for redundancy and a long term, predictable, high level of performance.

## **SUMMARY OF THE INVENTION**

In view of the foregoing disadvantages in the known types of hard drive storage systems, the present invention provides a new solution wherein the same can be utilized for the storage of multiple hard drives.

A key aspect of the hard drive haven is to look at the problem of reliable hard drive performance from the opposite vantage point that it is usually viewed. The norm is to look at improving the HDDs, while simultaneously increasing their capacity and rotational speeds. The hard drive haven provides a benign environment for disk drives. It provides a total solution to all the requisite hard drive performance diminishing threats. In addition, it provides a structurally sound and inexpensive method for OEMs to package the hard drives. The hard drive haven is a total value proposition, unparalleled in the market today.

The general purpose of the present invention, which will be described subsequently in greater detail, is to provide the industry with a new hard drive storage system that has many of the advantages of the hard drive haven mentioned heretofore and many novel features that result in a better environment which is not anticipated, rendered obvious, suggested, or even implied by any of the prior solutions, either alone or in any combination thereof.

There has thus been outlined, rather broadly, the more important features of the invention in order that the detail description thereof may be better understood, and in order that the present contribution to the art may be better appreciated. There are additional features of the invention that will be described hereinafter.

In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology

employed herein are for the purpose of the description and should not be regarded as limiting.

A primary object of the present invention is to provide a storage solution system that will overcome the shortcomings of all other solutions.

An object of the present invention is to provide a cost efficient means for multiple hard drives to reside within a computer, a network storage array, a PC, a commercial digital device and other peripherals that contain hard drives:

Another object is to provide a solution with no mechanical parts, and no electro-mechanics and provide exceptional performance.

Another object is to provide a solution where the airflow passages are optimized.

Another object is to provide a solution that has an excellent thermal environment.

Another object is to provide a solution that reduces vibration (external and drive to drive, RV), shock, and acoustic noise.

Another object is to provide a solution that allows ease of distribution and replacement for hard drives in the field (shipped in original packaging).

Another object is to provide a solution that is structurally sound and minimizes mass.

Another object is to provide a solution that provides electrostatic discharge and electrical grounding isolation for the HDDs.

Another object is to provide a solution that allows for highly reliable interconnect without the need for any mechanical alignment features.

Another object is to provide a solution that provides a low cost overall Solution for the packaging of hard drives.

Another object is to provide a completely snap fit assemble.

Another object is to manage polymers in a vibration damping environment that has exceptional durability. This by using a variety of beam elements that work in unison to off load and not allow the over stressing of any other beams in the structure.

Another object is to provide a common platform for mounting of hard drives to provide a predictable, benign and fully optimized solution to promote long term reliable hard drive performance.

Another object is to standardize this platform in order to better compile consistent data of hard drive performance to continue to drive the technology to greater levels of capacity and performance.

Another object is to provide the first complete solution for hard drives , from the manufacturer to end of life of each individual hard drive.

Other objects and advantages of the present will become obvious to the reader and it is intended that these objects and advantages are within the scope of the present invention.

To the accomplishment of the above and related objects, this invention may be embodied in the form illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that changes may be made in the specific construction illustrated. The exceptional principles embodied in the hard drive Haven will be maintained, and over time enhanced in anyway possible, for any version of the structure offered to the market place. As is a philosophical note, the ultimate purpose of the Hard Drive Haven is to promote learning. Reliable computers and computer networks will provide a greater level of access to information and it is information that can promote learning and through learning we all can attain a higher level of understanding. It is to this vision that the Haven is dedicated.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

Various other objects, features and attendant advantages of the present invention will become fully appreciated as the same becomes better understood when considered in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the several views, and wherein. Please note that the drawings shown here are of the least complex beam structures, as this demonstrates the principle most clearly. There are a great range of beam cross sections and combinations that are under analysis and being shaped to optimize the Haven's performance. In later pages there will be drawings of a number of beam shapes and combinations rendered to demonstrate a small sample of the wide range of form factors that could and will be used to satisfy the needs of hard drives and other devices needing an environmental Haven.

FIG. 1 is a perspective view of the present invention.

FIG. 2 is a front of the present invention showing all of the components.

FIG. 3 is a side view of the present invention.

FIG. 4 is a perspective view of the faceplate interfaces to the drive and the present invention.

FIG. 5 is a partially exploded view of the present invention.

In Appendix A

FIG. A1 show a number of conceptualizations of the types of features that might be used of the present invention.

**Figure 1 - Perspective View of the Hard Drive Haven**

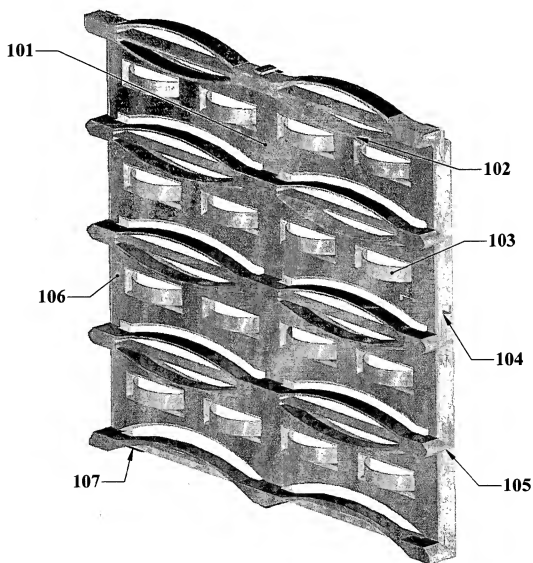


Figure 2 - Front View of the Hard Drive Haven

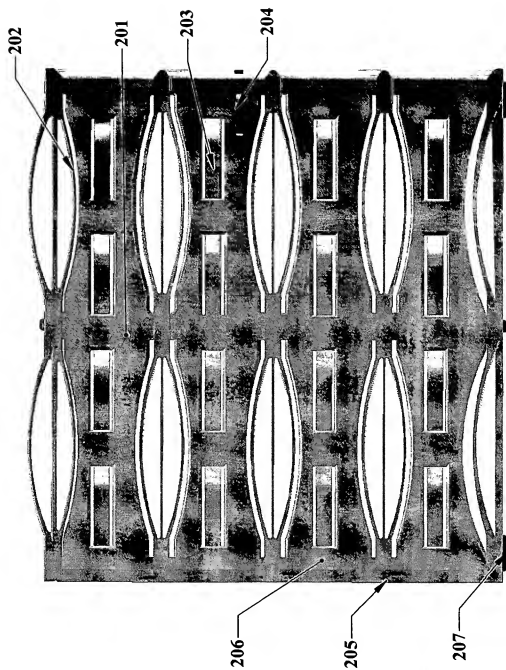


Figure 3 - Side View of the Hard Drive Haven

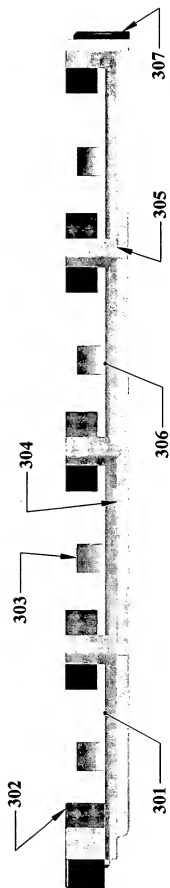




Figure 4 - Perspective View of the Hard Drive Haven Faceplate

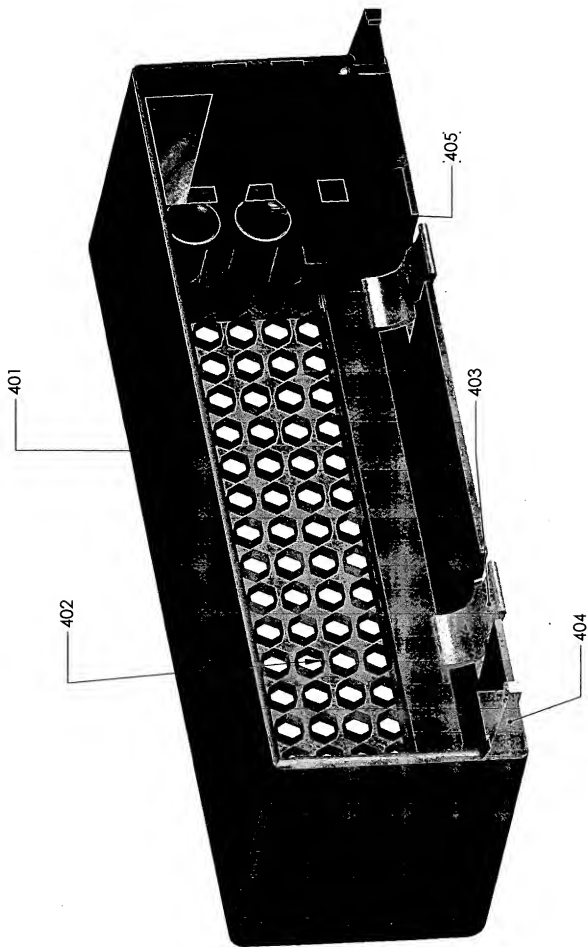
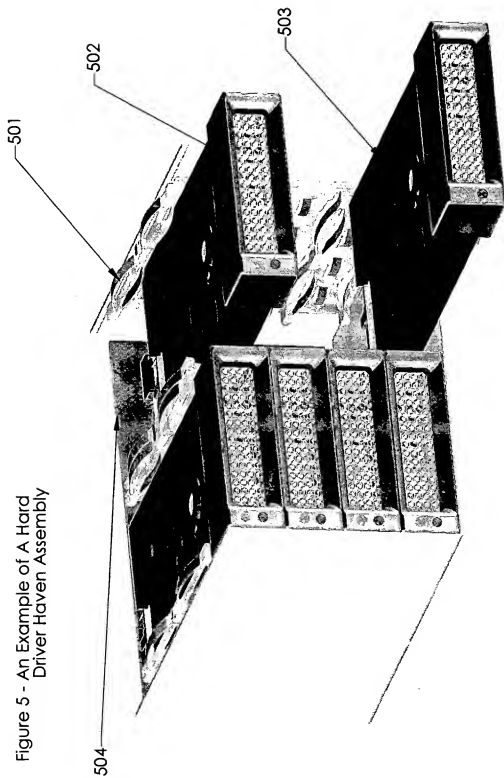


Figure 5 - An Example of A Hard  
Driver Haven Assembly



## **DETAILED DESCRIPTION OF THE INVENTION**

Turning now descriptively to the drawings, in which similar reference characters denote similar elements throughout the several views, the attached figures illustrate a hard drive mounting structure which is comprised of a polymer.

Polymer composites have excellent damping properties that can be used to help control any unwanted vibrations produced by external dynamic loading. Moreover, the great flexibility available in composite structures through changing both materials and designs can be used to alter damping and resonance properties in desirable ways. See enclosed documents regarding these composites. Examples of appropriate polymers for computer applications include Delrin, Celanese, and Celstran. There are many polymers that could be candidates for the Hard Drive Haven. There are many polymers that offer the properties that will be required for the hard drive haven. Ultem, Valox and Noryl are three such polymers, as examples. Careful analysis, including finite element modeling will be necessary to ensure that the polymer(s) used can withstand the test of time and not yield as a result of creep and/or fatigue.

The Hard Drive Haven has a vibration dampening system that will damp vibration to and from other co-located hard drives and/or from external excitations from the local environment. The vibration that is created from other hard drives is referred to as RV, which stands for Rotational Vibration. Hard drive have rotating platters and this rotational energy can be transmitted from one hard drive to another and cause the receiving drive to experience a drop in performance. The hard drive Haven will utilize a very carefully structured series of beams that will combine in damping out vibration and acoustic noise over a wide range of frequencies and energy levels. The vibration dampening features will be molded from the structure that also serve as the support structure for the hard drives and as a stiffening system for the computer, server, storage array, digital recorder, desktop hard drive enclosure and many other possible applications. The focus herein is on hard drives but the application of this solution is extendable to any number of devices that are benefited by having vibration, shock and acoustic vibration damped from their operating environment.

The drawings shown herein reflect only a few of the possible beam structures that can be employed by the Hard Drive Haven. The HDH (Hard Drive Haven) will be designed to be capable of responding to a great number of inputs and damping out the negative effects be having one beam support another and another support another, etc. With no beam beings tresses and or strained past the limits of the material used ensuring that the HDH prevails for the life of the product. The inventive suspension system holds the hard drive in a slot in the housing with the polymer springs. The polymer springs isolate the hard drive from the side panels and dampens the vibration produced by the hard drive itself as well as the vibrations transmitted through the sidewalls of the hard drive bay housing. The springs will provide constraint and damping in an omni-directional manner, negating the adverse effects of vibration and acoustic noise from any conceivable source within the operating environment.

With reference to Figure 1, a side panel 101 of a housing that incorporates an embodiment of the inventive hard drive suspension system is shown. Another side panel is mounted in parallel 501 with the illustrated panel so that both sides of the hard drives are in contact with the polymer springs. In the illustrated embodiment (which is only one configuration of many possible, single drive up to as many as required by the application), there are slots 106 for four hard drives which are separated by dividers 105. The inventive suspension system comprises a polymer compression member which in this embodiment is an arched beam 102 that is incorporated into each of the dividers 105, contact the hard drives on the upper and lower surface of the devices. In addition there are compressive members 103 that contact the hard drives on the sides of the devices and compress as the drives are inserted into the hard drive haven. The beams are therefore in compression in both the vertical 102 and horizontal 103 axis of the hard drives and due to the nature of the forces that ill be encountered and the nature of the polymers will act as omni-directional; reactions to all forces. The actual hard drive haven will employ beams of similar conceptual design, but may be very different in form factor as a result of detailed finite analysis. The greatest likelihood is that multiple beams of varying stiffness will be employed to react the multiplicity of stimuli the hard drives will encounter in operation. The diagrams enclosed are therefore intended to represent the concept and do so from a fundamental conceptual point of view. The multi stiffness beams will be designed to work in unison with each other being recruited as the load becomes more aggressive , for example in shock, but not allow the load to be too great on lesser strength beams before a stiffer load bearing beam is recruited.

In an embodiment, the inventive suspension system also has springs that engage the sides of the hard drive. These springs are similar to springs in the dividers but are mounted in the center of the slots of the side panel. The side springs are made of a flexible polymer and have an arched structure that is attached at the ends of the beam to the side panel.

In an embodiment, the inventive suspension system also has springs that engage the sides of the hard drive. These springs are similar to springs in the dividers but are mounted in the center of the slots of the side panel. The side springs are made of a flexible polymer and have an arched structure that is attached at the ends of the beam to the side panel.

The hard drive haven will also deliver a very structurally efficient solution. The strength to weight ratio of properly molded plastics is far in excess of cold rolled steel (which is almost always used in such applications...mass of polymer is  $\sim 1/8$  that of cold rolled steel). This is very important as the mass of the systems including multiple hard drives is increasing and the floor loading of data centers will not be able to accommodate bays that are filled with such mass dense packaging.

The hard drive haven is also provides a extremely assembly conscious design. The hard drive haven will snap fit into a sheet metal chassis. Feature 107 is a tongue (3 along the bottom of the bottom of the HDH and one at top center) that will fit into a slot in the sheet metal chassis (in the case where this is the final implementation). The top springs 102 will maintain the HDH in compression between the upper and lower sheet metal housing. The HDH also will include integral faceplates that provide a single snap-fit for the drive to the faceplate 403 and a single snap fit for the hard drive/faceplate combination in to the HDH 104/404. Therefore for applications (Enterprise or example) that HDH requires only three snap fit assembly steps for full HDH , hard Drive and faceplate assembly. With the use of metalized plastics that Electro-magnetic aspects of an enterprise solution can also be accommodated. It will often be necessary in enterprise applications to accommodate light pipes to provide optical feedback that the hard drives are operating correctly. These light pipes can easily be accommodated in the HDH side walls.

Figure 5 shows an example assembly of eight hard drives. The hard drives can be mounted right side up or upside down (as shown) 503. System architecture will dictate the most prudent choice in this case. The HDH can package the drives in very close proximity, but provide the necessary cooling air, structural integrity, vibration/shock/acoustic damping, ease of assembly, and a multitude of other benefits that are all delivered at an exceptionally low cost.

At the present there are many companies packaging hard drives in closer and closer proximity with each other. There are metal boxes in metal boxes, in... My point is that the Haven considers this and requires virtually no packaging, accepting the drive into the shelf with nothing but a faceplate. This leaves all of the cross-sectional area between the drives free for delivering cooling air. This is important for the drives, but it is also very important for other system components, downstream of the drives, these components, often containing processors, can reject a great deal of heat. It is critical that drives be well cooled, and that the portion of system they reside in is not so densely packaged so as to slow the flow in the entire system. The HDH makes sure that as much of the critical airflow volume is available for the system components.

Normal mounting systems place many hard drives close proximity in an enclosed space. This results in very limited circulation of cooling air to dissipate the heat produced by the hard drives. In contrast, the inventive suspension system has numerous cutouts in the side panels. These holes are located next to the tops and bottoms of the hard drives and they allow air to more freely flow over the upper and lower surfaces. Because of the increased air flow, the inventive system can more easily cool the stacked hard drives through convection heat transfer.

The thermal environment – it is a widely held opinion that the performance and length of time in which a hard drive will continue to function is inversely proportional to the temperature of the environment in which it operates. The actual degree to which the temperature is elevated is where the debate lies, but it is clear that the lower temperatures are better. With that said, one needs to understand the reality of where the hard drives will be deployed to realize that there is no good way to be certain of the ambient temperature that will be encountered and that this will be variable depending on what the final implementation is. Therefore, the drives will have to operate under a number of different environmental ambient temperature states. Since you cannot guarantee the

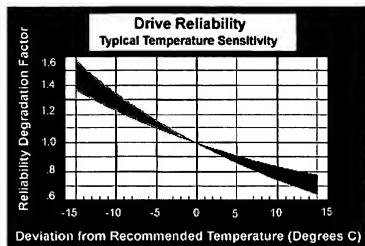
temperature of the cooling air, then it is critical to guarantee that there is enough air to effectively remove the heat that the drive itself generates. I now include the first graphic to assist in the description of the intellectual property described herein. Please note that the majority of the hard drive market is moving rapidly toward very dense packaging of hard drives to provide low cost data storage solutions. The increasing packaging density and the ever increasing capacity of the hard drive (Upwards of 500MB for one 3.5 inch HDD and climbing), making the thermal environment ever more aggressive for the hard drives and incrementally reducing the life expectancy of the hard drives. The need to get whatever little air possible to the drives and efficiently removing whatever heat possible is more critical than ever before. In order to help to demonstrate the manner in which the Hard Drive Haven addresses the thermal issues as well as many other aspects of hard drive packaging, the following diagram (Figure 1 - The Basic Form Fit & Function of the Hard Drive Haven) is submitted:

To look at an example of the relationship between temperature and hard drive (MTBF=Mean Time Before Failure; HDD = Hard Disk Drive).

**The following paragraph, figure, paragraph comes from a white paper entitled "Hitachi's Drive Temperature Indicator Processor (Drive-TIP) helps ensure high drive reliability" by Gary Herbst .**

### **Heat has a major effect on drive reliability**

Disk drives are complex electro-mechanical devices that can suffer performance degradation or failures due to a single event or a combination of events occurring over time. Environmental conditions that affect drive reliability include ambient temperature, cooling air flow rate, voltage, duty cycle, shock/vibration, and relative humidity. Fortunately, it is possible to predict certain types of failures by measuring environmental conditions. One of the worst enemies of hard disk drives is heat. Within a drive, the reliability of both the electronics and the mechanics (such as the spindle motor and actuator bearings) degrades as temperature rises. Running any disk drive at extreme temperatures for long periods of time is detrimental and can eventually lead to permanent data loss.



**Figure 6:** Drive reliability decreases significantly as temperature rises above recommended levels

Figure 6 shows the dramatic effect that temperature has on the overall reliability of a hard disk drive. Derivations from a nominal operating temperature (assumed to be maintained over the life of a drive) can result in a derivation from the nominal failure rate. As the temperature exceeds the recommended level, the failure rate increases two to three percent for every one degree rise above it. For example, a hard disk drive running for an extended period of time at five degrees above the recommended temperature can experience an increase in failure rate of 10 to 15 percent. Likewise, operating a drive below the recommended temperature can extend drive life.

Normal mounting systems rigidly attach the hard drive to the slots or bays of a storage unit with screws and sheet metal slot components that physically contact the hard drive. Because of this rigid connection outside vibration is transmitted to the drive and the vibrations produced by the hard drive are transmitted to other hard drives in the housing exacerbating the vibration problem. In contrast to a rigid connection, the inventive hard drive suspension system isolates the hard drive from the frame with polymer springs which effectively dampen the transmitted vibrations. The polymer springs allow the hard drive to move in all three axis. In addition to vertical movement, the hard drive may also move from side to side or forward and backward in the slot. This freedom of movement results in reduced vibration transmitted to the hard drive. In addition to the mechanical spring properties, the polymer also has vibration absorption characteristics. In a normal spring, the physical energy resulting from



compression is stored and released as the spring expands. In the preferred embodiment, the polymer springs are made of a material that absorbs some of the compression force and converts this energy into a different form. The energy may be converted into heat energy or alternatively, with a pizo-electric mechanism the physical energy can be converted into electrical energy.

This is an area in the mechanical packaging community where there are a variety of opinions and I truly believe that those that consider vibration a potential threat to hard drives know what they are talking about and those that pass it off as an "I don't care" case don't understand it and have taken the wrong steps in the packaging in many cases. This will show down the road when the failure rate is exceedingly high. Unfortunately this mixed opinion business has caused others who are not fully versed in the subject to cut short on the budget for vibration and all kinds of inferior solutions are emerging.

Polymers are effective in their response to a variety of vibration related issues, including: absorption of airborne sound; blocking airborne sound; damping, and vibration isolation. The Hard Drive Haven will employ polymers, composites and other appropriate materials in addressing all these issues, in a manner that is cost effective and delivers all requisite HDD packaging needs.

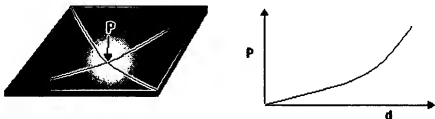
### **Shell Effect or Membrane Stiffening Effect**

For effective vibration control, it is often desirable to have a response that provides greater stiffness as the load increases. The behavior of Membrane or shell stiffness, in polymers, provides this behavior without incremental cost. Simple it is a function of the geometry. With proper material selection, the cross section can be matched to the expected loading of the application. Diaphragm stiffening is a nonlinear increase in stiffness resulting from a change in curvature of a part. This effect is particularly pronounced when fixed boundary conditions are used.

There are a variety of different materials that can be utilized depending on the devices form factors, level of damping required and

the magnitude of the input forcing function. Diaphragm stiffening is a nonlinear increase in stiffness resulting from a change in curvature of a part. This effect is particularly pronounced when fixed boundary conditions are used.

The stiffening effect results from the fact that the thin wall is stretched into tension as the plate deflects. The load deflection shown below, illustrates this phenomenon.



**Figure 7. Load Deflection.**

Enclosed you will find data sheets of polymers that may be applicable to this invention.

Simplified, lower mass and higher strength structures. Reduced packaging complexity, with increased reliability, serviceability, and ease of assemble. Ease of integration of industrial design features, ease of shipping replacements (could use the Haven or if not send drives in their original packaging and pop on a face plate at the site and slide into the Haven).

While the invention has been shown or described in only some of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the cope of the invention. For example, the dampening materials may be formed from a thin film, sheet, molded or a combination thereof, and may be placed at a variety of interfaces to further reduce vibration and shock.

## **ABSTRACT OF THE DISCLOSURE**

A hard drive haven system for hard drives in a multiple environment that meets thermal, structural, interconnect ability, reliability, and mechanical integrity as is mandated for the life of a hard drive. The inventive device, as illustrated, is made from polymer materials that enhance vibration absorption, and acoustic noise. This inventive device will reduce the cost of metal solutions as well.

## **DECLARATION**

As a below named inventor, We hereby declare that:

Our residence, post office address and citizenship are as stated below next to our names.

We believe we are the original, first and joint inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled

### **THE HARD DRIVE HAVEN**

the specification of which is attached hereto.

We further state that we do not know and do not believe that the above-named invention has ever been known or used in the United States before this invention thereof, or patented or described in any printed publication in any country before this invention thereof, or more than one year prior to this application, or in public use or on sale in the United States more than one year prior to this application; that the invention has not been patented or made the subject of any inventor's certificate in any country foreign to the United States on an application filed by me or my legal representatives or assigns more than six (6) months prior to this application; and that no application for patent or inventor's certificate on the invention has been filed by me or my representatives or assigns in any country foreign to the United States, except as identified below.


I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims (if included), as amended by any amendment if applicable.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are

punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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 Date: March 17, 2004

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